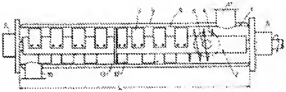
1) Family number: 3883431 (US4420892A) © PatBase

Title: Thin film contact dryer

Abstract: Source: US4420892A The thin film contact dryer consists of a rotor having flat rotor elements extending in a radial direction. In the central third of the rotor is arranged at least one combination of distributing elements and an annular weir which revolves with the rotor and leaves a narrow annular gap open to the internal dryer wall, the annular weir being arranged immediately downstream of the distributing elements as viewed in the direction of flow.



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DE2911549 A1	19800925	DE19792911549	19790323
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EP0017040 B1	19830302	EP19800101291	19800313
JP55149603 A2	19801121	JP19800034826	19800321
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(54) Dünnschichtkontakttrockner.

(57) Der Dünnschichtkontakttrockner besteht aus einem Rotor 2 mit flächenförmigen, sich in radialer Richtung erstreckenden Rotorelementen 3. Im mittleren Drittel des Rotors 2 ist mindestens eine Kombination von Verteilelementen 12 und ein mit dem Rotor umlaufendes Ringwehr 13 angebracht, das zur inneren Trocknerwand 9 einen schmalen Ringspalt 15 offen läßt, wobei in Strömungsrichtung gesehen das Ringwehr 13 unmittelbar hinter den Verteilelementen angeordnet ist.

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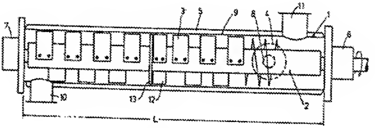

FIG 1

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22. März 1979

Dünnschichtkontakttrockner

Die Erfindung geht aus von einem Dünnschichtkontakttrockner mit einem Rotor. Durch den Rotor wird das eingetragene Feuchtgut immer wieder an die beheizte Innenwand des Trockners geschleudert bis es schließlich am anderen Ende des Trockners in rieselförmiger und trockener Form entnommen werden kann.

Bei Feuchtgütern, die als pumpbare Paste in einen Dünnschichtkontakttrockner eingespeist werden, bilden sich sehr häufig größere Produktagglomerate (Knollen), die in Erbsen- bis Haselnußgröße das sonst pulvrige Trockengut durchsetzen. Bei gegebener Granulationsneigung ist die Knollenbildung auch bei rieselfähigen Feuchtgütern möglich.

Die im Innern noch feuchten Knollen machen das Trockengut unbrauchbar, weil es den Forderungen für Restfeuchte, Mahlbarkeit und Handhabung nicht entspricht. Ein Absieben und Rückführen des Knollenanteils ist sehr aufwendig. Daher konnte der horizontale Dünnschichtkontakttrockner in den Fällen, in denen sich auch schon geringe Mengen an Knollen bildeten, bisher nicht eingesetzt werden.

Zu diesem Zweck sind zurückgebogene Verteilelemente entwickelt worden, die die Knollen dadurch verhindern sollten, daß das Produkt in den konischen Spalt zwischen Verteilelementen (umlaufend) und der zylindrischen Heizfläche (ruherd) ingezogen und verstrichen wird. Es zeigte sich jedoch, daß damit zwar eine merkliche, aber in keinem Falle ausreichende Verringerung des Knollenanteils im Trockengut erzielt werden konnte.

Ein anderer Vorschlag beruht darauf, durch Schrägstellen des Trockners die Produktverweilzeit soweit zu erhöhen, daß die Knollen vernichtet werden. Dabei ergeben sich jedoch infolge der erhöhten Produktmenge im Trockner unzulässige mechanische Beanspruchungen am schnelllaufenden Rotor.

Der Erfindung liegt die Aufgabe zugrunde, einen Dünnschichtkontakttrockner zu entwickeln, der in jedem Falle ein knollenfreies pulverförmiges Trockengut liefert.

Diese Aufgabe wird erfindungsgemäß dadurch gelöst, daß im mittleren Drittel des Rotors mindestens eine Kombination

von Verteilelementen und einem mit dem Rotor umlaufenden Ringwehr angebracht ist, das zur inneren Trocknerwand einen schmalen Ringspalt offen läßt. Dabei ist in Strömungsrichtung gesehen das Ringwehr unmittelbar hinter den Verteilelementen angeordnet.

Vorteilhaft ist dabei die Weite d des Ringspaltes größer als der Abstand s der Verteilelemente von der Trocknerwand.

Bei Substanzen, die besonders stark zum Klumpen und zur Knollenbildung neigen, hat sich eine Ausführungsform bewährt, bei der mehrere Einheiten von Verteilelementen und Ringwehr hintereinander geschaltet sind.

Durch den Ringspalt wird die Förderung der schon pulvrig rieselfähigen Produktanteile, die durch die hohen Fliehkräfte in dünner Schicht über den Trocknerumfang verteilt werden, nicht behindert. Dagegen werden die Knollen vom Ringwehr solange zurückgehalten, bis sie von den Verteilelementen erfaßt werden und zu Pulver zerkleinert ebenfalls den Ringspalt passieren können. Die Partikelgröße des Trockengutes entspricht dann maximal der Weite des Ringspaltes. Ein besonderer Vorteil liegt darin, daß keine komplizierten Umbauten am Dünnschichttrockner erforderlich sind. Ringwehr und zugehörige Verteilelemente können auch nachträglich leicht in bereits vorhandene Anlagen eingebaut werden. Auf diese Weise können die zahlreichen Vorteile des Dünnschichtkontakttrockners auch für solche Produkte genutzt werden, die wegen ihrer Neigung zum Agglomerieren bzw. zur Knollenbildung bisher in anderer Weise getrocknet werden mußten.

Im folgenden wird ein Ausführungsbeispiel der Erfindung anhand von Zeichnungen näher erläutert. Es zeigen

Fig. 1 den prinzipiellen Aufbau eines Dünnschichttrockners,

Fig. 2 einen Ausschnitt des Dünnschichttrockners mit Verteilelementen und Ringwehr,

Fig. 3 einen Schnitt A/B gemäß Figur 2.

Der Dünnschichtkontakttrockner gemäß Fig. 1 wird grundsätzlich horinzontal aufgestellt. Seine wesentlichen Bestandteile sind das zylindrische Gehäuse 1, der Rotor 2 mit Rotorelemente 3 und die Eintragschnecke 4 am rechten Ende. Bei den Rotorelementen handelt es sich in bekannter Weise um Förder-, Feder- und Umwälzelemente. Das Trocknergehäuse 1 ist mit einem Heizmantel 5 versehen. An den Enden des Trockners befinden sich Abschlußflansche 6 und 7. Das zu trocknende pastenförmige Gut wird im Bereich der Eintragsschnecke 4 durch den Stutzen 8 eindosiert. Anschließend wird es von den Rotorflügeln 3 erfaßt und an die Innenwand 9 des Trockenraumes geschleudert. Aufgrund der auftretenden Zentrifugalkräfte bleibt die Produktförderung auf eine schmale ringförmige Zone an der Trocknerinnenwand 9 beschränkt. Das getrocknete Produkt wird am Produktaustrag 10 am linken Ende des Trockners entnommen. Die entstehenden Brüden werden durch den Stutzen 11 abgesaugt.

Im mittleren Drittel des Trockners ist der Rotor mit einem Ringwehr 13 und den zugehörigen Verteilelementen 12 bestückt (s. vergrößerter Ausschnitt gemäß Fig. 2 und 3). Das Ringwehr 13 folgt in Strömungsrichtung gesehen, d.h. von rechts nach

links, unmittelbar auf die zugehörigen Verteilelemente 12. Die Form des Ringwehrs 13 und der zugehörigen Verteilelemente 12 ist aus Fig.3 ersichtlich. Die Verteilelemente 12 bestehen aus zurückgebogenen Blechen, die zentral am Rotor 2 befestigt sind und unmittelbar vor der Innenwand 9 des Trockners enden. Der Abstand s zwischen der Außenkante der Verteilbleche 12 und der Innenwand 9 liegt z.B. in der Größenordnung von 1 mm. Das unmittelbar darauf folgende Ringwehr 13 besteht aus einer ringförmigen Scheibe, die in der Mitte durch Stege 14 am Rotor 2 befestigt ist. Der Radius der ringförmigen Scheibe ist so bemessen, das zwischen ihrem äußeren Rand und der Innenwand 9 des Trockners ein schmaler Ringspalt 15 verbleibt. Seine Spaltweite d muß größer sein als der Spalt s zwischen den Verteilelementen 12 und der Trocknerwand 9. Er liegt in der Praxis zwischen 2 und 5 mm. Nach Möglichkeit soll das Ringwehr 13 bündig an die Verteilelemente anschließen. Der Abstand Ringwehr - Verteilelemente darf aber keinesfalls größer sein, als die Weite d des Ringspaltes 15.

Das Feuchtgut 16, das teilweise zu Knollen 17 agglomeriert ist, wird aufgrund der Zentrifugalkräfte an der Innenwand 9 des Trockners entlangtransportiert und dabei durch die vom Heizmantel 5 zugeführte Wärme getrocknet. Sobald die Knollen 17 in den Einzugsbereich der Ventilelemente 12 gelangen, werden sie durch Druck und Reibung zerkleinert. Das Ringwehr 13 verhindert, daß die Knollen 17 zwischen den zugehörigen Verteilelementen 12 hindurchrollen und von diesen überhaupt nicht erfaßt werden. Die Wirkungsweise der Ringwehrs 13 besteht also darin, daß im Bereich der zugehörigen Verteilelemente 12 ein Rückstau der Knollen 17

auftritt. Durch die großen halbkreisförmigen Öffnungen 18 im Ringwehr 13 können die Brüden ungehindert abströmen. Den gleichen Zweck wie das beschriebene Ringwehr 13 würde daher auch eine Stauscheibe mit Öffnungen (zum Durchtritt der Brüden) erfüllen.

Bei besonders stark agglomerierenden Produkten kann die Wahrscheinlichkeit der Knollenbildung noch weiter herabgesetzt werden, wenn mehrere Einheiten von Ringwehr 13 und Verteilelementen 12 im Trockner hintereinander geschaltet werden.

Die Lage einer solchen Einheit im Trockner ist nicht sehr kritisch. Es empfiehlt sich jedoch, das Ringwehr in Verbindung mit den zugehörigen Verteilelementen in einer Entfernung vom Produkteintrag 8 anzubringen, die mindestens 1 Drittel und höchstens 2 Drittel der Rotorlänge L entspricht. Wird das Ringwehr 13 zu nahe am Eintrag 8 angeordnet, so kann der Spalt 15 durch noch nicht in die Pulverphase überführtes Produkt verstopft werden. Bei einer Anbringung zu nahe am Produktaustrag 10 ist andererseits nicht mehr gewährleistet, daß die zerkleinerten Knollenbestandteile noch ausreichend getrocknet werden.

Bei Versuchen mit dieser Vorrichtung ergab sich, daß auch bei stark agglomerierenden Substanzen (starke Neigung zu Knollenbildung) im Trockengut am Produktaustrag 10 nur noch Partikel mit einer Korngröße $\ll$ d vorhanden waren. Damit konnte der Anwendungsbereich für Dünnschicht-

kontakttrockner auch auf knollenbildende Produkte erweitert werden. Ein wichtiger wirtschaftlicher Aspekt der Erfindung liegt ferner darin, daß Ringwehr 13 und zugehörige Verteilelemente 12 jederzeit nachträglich in vorhandene Anlagen eingebaut werden können.

Patentansprüche

1. Dünnschichtkontakttrockner mit einem Rotor, dadurch gekennzeichnet, daß im mittleren Drittel des Rotors (2) mindestens eine Kombination von Verteilelementen (12) und einem mit dem Rotor umlaufendes Ringwehr (13) angebracht ist, das zur inneren Trocknerwand (9) einen schmalen Ringspalt (15) offen läßt, wobei in Strömungsrichtung gesehen das Ringwehr (13) unmittelbar hinter den Verteilelementen angeordnet ist.

2. Dünnschichtkontakttrockner nach Anspruch 1, dadurch gekennzeichnet, daß die Weite d des Ringspaltes (15) größer ist als der Abstand s der zugehörigen Verteilelemente (12) von der Trocknerwand (9).

3. Dünnschichtkontakttrockner nach Anspruch 1 und 2, dadurch gekennzeichnet, daß mehrere Einheiten von Ringwehr (13) und zugehörigen Verteilelementen (12) hintereinander geschaltet sind.

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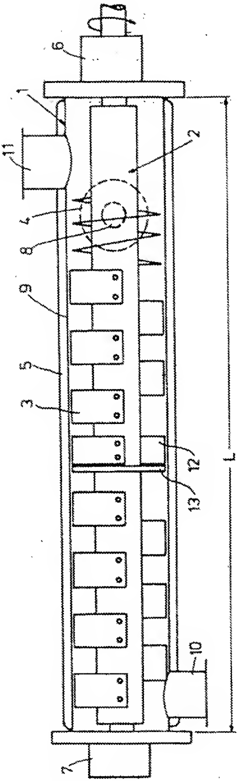

FIG. 1

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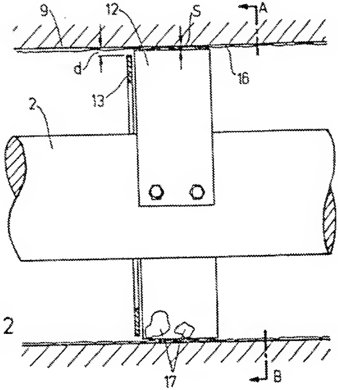

FIG. 2

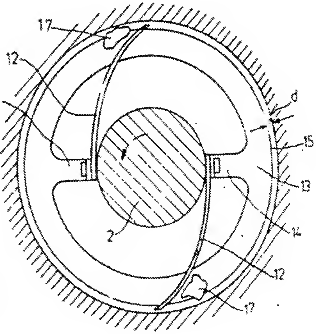

FIG. 3
(A-B)

Europäisches Patentamt

EUROPÄISCHER RECHERCHENBERICHT

Nummer der Anmeldung

EP 80 10 1291

EINSCHLÄGIGE DOKUMENTE			KLASSIFIKATION DER ANMELDUNG (Int.Cl. 3)
Kategorie	Kennzeichnung des Dokuments mit Angabe, soweit erforderlich, der maßgeblichen Teile	betrifft Anspruch	
	DE - A - 2 724 281 (MAMISTOV) * Seite 5, Zeile 16 - Seite 8, Zeile 11 * --	1-3	F 26 B 11/16 3/22
	GB - A - 1 174 072 (SEISAKUSHO) * Seite 1, Zeile 46 - Seite 2, Zeile 50 * --	1	
A	FR - A - 993 243 (AMBARD) * Ganzes Dokument * --	1	RECHERCHIERTE SACHGEBIETE (Int. Cl. 3)
A	GB - A - 7198 AD 1915 (LIQUID PURIFICATION COMPANY) * Ganzes Dokument * --	1	F 26 B
A	DE - A - 2 228 682 (LUWA) * Ganzes Dokument * --	1	
A	GB - A - 11 028 AD 1912 (BOARDMAN) * Ganzes Dokument * ----	1	

KATEGORIE DER GENANNTEN DOKUMENTE

X: von besonderer Bedeutung
A: technologischer Hintergrund
O: nichtschriftliche Offenbarung
P: Zwischenliteratur
T: der Erfindung zugrunde liegende Theorien oder Grundsätze
E: kollidierende Anmeldung
D: in der Anmeldung angeführtes Dokument
L: aus andern Gründen angeführtes Dokument
&: Mitglied der gleichen Patentfamilie, übereinstimmendes Dokument

X Der vorliegende Recherchenbericht wurde für alle Patentansprüche erstellt.

Recherchenort	Abschlußdatum der Recherche	Prüfer
Den Haag	03-07-1980	DE RIJCK

Europäisches Patentamt
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Publication number: 0 293 103
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Treating matter.

Matter to be treated is passed through at least two treating regions 12, 14 sequentially. In each region a bed 29, 31 of the matter is moved in a band continuously along an annular path by passing fluid through the bed along the path. The annular paths of the regions 12, 14 are concentric.

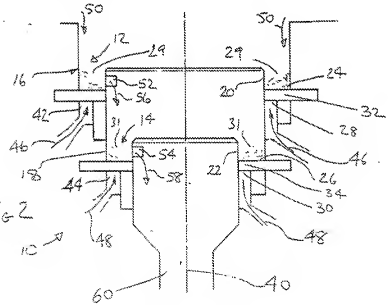

Fig 2

EP 0 293 103 A2

TREATING MATTER

This invention relates to treating matter, for example particulate and/or liquid matter.

Our specification EP-B-68853 discloses apparatus for treating mater defined by a structure including a base provided with an annular fluid inlet means, means for supplying fluid to the annular inlet fluid means and means for imparting vertical and circumferential components to the flow of fluid through the inlet means for moving a bed of said matter in said region in a band along an annular path in said region as said fluid passes through said bed.

We have now devised a development of the apparatus disclosed in the above-mentioned European patent specification which is advantageous in certain applications in that it increases the capacity of apparatus of a given overall size and/or provides for more efficient treatment of particular classes of matter.

The invention includes apparatus for treating matter, comprising at least two treating regions, each region being defined by a structure including a base provided with an annular fluid inlet means, the annular inlet means of the regions being disposed concentrically about an upwardly directed axis of the apparatus, means for supplying fluid to each annular fluid inlet means and means for imparting vertical and circumferential components to the flow of fluid through each inlet means for moving respective beds of said matter in regions in respective bands along respective concentric annular paths in said regions as said fluid passes through said beds.

The annular inlet means of said regions may be spaced axially and/or radially.

When the inlet means are spaced both axially and radially preferably the axially upper of the annular inlet means is disposed radially outwardly of the other annular inlet means. Furthermore, when there are more than two of said regions, the or each of the annular inlet means which are disposed axially below the axially upper annular inlet means are disposed radially inwardly of the inlet means next above it.

When the annular inlet means of the regions are spaced axially, the apparatus preferably further comprises means for supplying matter to be treated to the region provided with the axially upper of the annular inlet means, means for enabling matter to be extracted from the region provided with the axially lower of the annular inlet means and means for transferring matter from the or each region whose annular inlet means is disposed above that of another region to said other region.

When the annular inlet means of the regions are spaced radially, the apparatus may comprise means for supplying matter to be treated to the region provided with the radially outer of the annular inlet means, means for enabling matter to be extracted from the region provided with the radially inner of the annular inlet means, and means for transferring matter from the or each region whose annular inlet means is disposed radially outwardly of that of another region to said other region. Such an arrangement enables the matter to pass sequentially through the regions.

Alternatively, when the annular inlet means of the regions are spaced radially, the apparatus may comprise means for supplying matter to be treated to the region provided with the radially outer of the annular inlet means, and means for transferring matter from the or each region whose annular inlet means is disposed radially inwardly of that of another region to said other region. Such an arrangement is preferred when the annular inlet means of the regions are spaced both axially and radially.

The invention also includes a method of treating matter in at least two treating regions, wherein in each region a bed of said matter is moved in a band continuously along an annular path by passing fluid through the bed along said path, the annular paths of the regions being concentric. The concentric annular paths may be spaced axially and/or radially.

When the annular paths are spaced both radially and axially, preferably the axially upper of the annular paths is disposed radially outwardly of the other annular path or paths. Furthermore, in such a method when the matter is passed through more than two regions, the or each annular path is disposed radially inwardly of the annular path next above it.

In a method in which the annular paths are spaced axially, preferably the matter to be treated is supplied to the region having the axially upper of said annular paths and extracted from the region having the axially lower of said annular paths, the matter being transferred from the or each region having an annular path disposed above that of another region to said other region.

In a method in which the annular paths are spaced radially, the matter to be treated may be supplied to the region having the radially inner of said paths and extracted from the region having the radially outer of said paths, the matter being transferred from the or each region whose annular path is disposed radially inwardly of that of another region to said other region.

Alternatively when the annular paths are spaced radially, the matter to be treated may be

supplied to the region having the radially outer of said paths and extracted from the region having the radially inner of said paths, the matter being transferred from the or each region whose annular path is disposed radially outwardly of that of another region to said other region. Such a procedure is presently preferred when the annular paths are spaced both axially and radially.

The fluid which is passed through the beds may comprise gaseous matter which treats, or reacts with, the matter in said beds.

This gaseous matter may comprise combustion gases which heat the matter in said beds during passage through said beds.

Additionally or alternatively the fluid which is passed through said beds may comprise liquid matter which treats, mixes with, or reacts with the matter in said beds during passage through said beds. Additionally or alternatively the fluid which is passed through said beds may comprise air.

The matter which is passed through the treating regions may comprise particulate matter and/or liquid matter.

In order that the invention may be well understood, an embodiment thereof will now be described, by way of example only, with reference to the accompanying schematic drawing, in which:

Figure 1 is a top plan view of an apparatus for treating matter; and

Figure 2 is an aerial cross-section of the same apparatus taken along the line II-II in Figure 1.

The apparatus 10 shown in the drawing comprises two treating regions 12 and 14 through which matter to be treated sequentially passes. Each region 12, 14 is bounded externally by a respective tubular wall 16, 18 and in the illustrated apparatus, both chambers 12 and 14 are annular, being bounded internally by respective tubular walls 20, 22. Each region 12, 14 has a base 24, 26 provided with an annular fluid inlet 28, 30 which is spanned by an annular array of inclined vanes 32, 34. For simplicity, only a portion of the arrays of vanes is illustrated in Figure 1. However, it is to be understood that each array extends completely around the respective inlets 28, 30. The vanes which in the embodiment are fixed and arranged in overlapping relationship are inclined in order to impart vertical and circumferential components to the flow of fluid through the inlets 28, 30 for moving respective beds of the matter in the regions 12 and 14 in respective compact bands continuously along respective annular paths in the regions as the fluid passes through the matter in the beds. The bands are indicated at 29 and 31 respectively in Figure 2.

The annular inlets 28 and 30, and thus the annular paths in the regions 12, 14 along which the beds of matter is moved, are disposed concentrically about an upwardly directed axis 40 of the apparatus.

In the illustrated embodiments, the annular inlets and the annular paths associated therewith are spaced both axially and radially, with the upper of the annular inlets (and the annular path associated therewith) disposed radially outwardly of the other annular inlet (and the annular path associated therewith). This arrangement is particularly advantageous in that it enables the internal tubular wall 20 of region 12 to be formed as a continuation of the external tubular wall 18 of the region 14.

The fluid which is passed through the beds of matter to move the beds continuously along the annular paths in the regions 12 and 14 is directed to the annular inlets 28 and 30 through respective supply passages 42, 44 beneath the inlets as indicated by arrows 46, 48 in Figure 2.

The illustrated apparatus is provided with an inlet at its upper end to enable matter to be treated to be supplied to the region 12 as illustrated by arrows 50 in Figure 2. The internal tubular walls 20 and 22 of the regions 12 and 14 are provided with respective openings 52, 54. The opening 52 enables matter to be transferred from region 12 to region 14 as indicated by arrow 56 in Figure 2, and the opening 54 enables matter to be extracted from the region 14 as indicated by arrow 58 in Figure 2. The matter extracted from region 14 exists the apparatus via outlet 60.

In use, matter is supplied to the region 12 to form a bed therein which is moved in band 29 continuously along an annular path by passing fluid through the bed along that path and is treated in region 12. The cross-sectional size of the band 29 of matter being moved in region 12 depends upon the amount of matter in that region. Initially, when matter is first supplied to the region 12, the band has a small cross-section and moves adjacent the external wall 16. On introduction of further matter, the cross-section of the band increases both radially inwardly and axially upwardly such that when the matter in region 12 exceeds a predetermined amount, excess matter will exit the region 12 through opening 52, to be transferred to region 14 to form a bed therein which is moved in a band continuously along an annular path by the fluid which is passed through the bed along that path, and be treated in region 14. As with the band 29, the cross-sectional size of the band 31 of matter being moved in the region 14 depends on the amount of matter in that region. Likewise, initially when matter is first transferred to the region 14 from region 12, has a small cross-section and moves adjacent the external wall 18 of region 14. On transfer of further matter, the cross-section of the band 31 increases both radially inwardly and axially upwardly such that when the amount of

matter in region 14 exceeds a predetermined amount, excess matter exits from region 14 through opening 54.

Thus, it will be appreciated that once the two regions 12 and 14 contain the above-mentioned predetermined amounts of matter, supply of further matter to region 12 results in matter being transferred from region 12 to region 14 and matter being extracted from region 14. In this way a throughput of matter is achieved, the matter passing sequentially through the two regions 12 and 14 before exiting the apparatus.

The above described apparatus and method are particularly advantageous for treating matter which after being treated does not automatically rise from the bed to exit from the apparatus (as is the case for example when perlite is expanded by being heated by combustion gases which are passed through the bed as described in our specification EP-B-68853). Although there is no control in how long particular matter is retained in region 12 before being transferred to region 14 nor how long particular matter is retained in region 14 before exiting the apparatus, the fact that the matter being treated is passed through two regions enables an average treatment time to be achieved. If the treatment time is particularly critical, more control over the treatment time may be achieved by modifying the apparatus to include a further region or regions like regions 12 and 14 having annular paths concentric with the annular paths provided by regions 12 and 14. Thus, for example the illustrated apparatus could be modified to have a further region provided with an annular inlet spaced axially below and radially inwardly of inlet 30 of chamber 14. In this case, it will be appreciated that matter would be transferred from region 14 to this further region and eventually exit the apparatus from the further region.

The matter which is passed through the treating regions may comprise particulate matter and/or liquid matter. The fluid which is passed through the beds may comprise gaseous matter which treats, or reacts with the matter in the beds. For example, the gaseous matter may comprise combustion gases which heat the matter in the beds during passage through the beds. One particular example, is the case where the matter being treated comprises coffee beans which are roasted as they pass through the regions by combustion gases. Another example is where the matter to be treated comprises a slurry from which the liquid is driven off by the combustion gases.

The fluid which is passed through the beds may comprise liquid matter which treats, mixes with, or reacts with the matter in the beds during passage through the beds. Again in this case, the matter in the beds may comprise particulate matter and/or liquid matter. For example, the liquid which is passed through the beds may chemically react with matter in the beds comprising solid particulate matter suspended or dissolved in liquid matter.

The fluid which is passed through the beds may alternatively comprise air in which case the purpose of the fluid may be merely to move the matter in the beds along their annular paths. For example, the matter in the beds may comprise particulate matter and liquid matter which coats the particulate matter as both the particulate matter and liquid matter are moved along the annular paths.

It will also be appreciated that a different fluid may be passed through each bed to enable different treatments to be carried out on the matter when it is in each bed.

It will be appreciated from the above that by providing a plurality of treating regions through which the matter to be treated passes sequentially and in which the matter is moved along respective concentric annular paths, the path length for the matter (and thus the capacity of the apparatus) is increased for a given overall size as compared with the apparatus disclosed in our specification EP-B-68853 where only one treating region having an annular path is present.

Whilst the embodiment discloses one particular arrangement of concentric paths in which two annular paths are spaced both axially and radially with the axially upper of the annular paths disposed radially outwardly of a lower annular path, it is to be understood that more than two annular paths may be provided and that these paths may be spaced only radially or only axially. Furthermore, whilst in the embodiment the matter to be treated is supplied to the region having the radially outer path and extracted from the region having the radially inner path, it is envisaged that matter may be supplied to a region having the radially inner path and extracted from a region having the radially outer path.

Whilst in the above-described apparatus and method, the matter is passed sequentially through the concentric regions, it is to be understood that this is not essential and instead matter can be supplied directly to respective concentric regions and treated only in one such region. Such an embodiment of the invention can be advantageously utilised when the matter being treated in the beds does automatically rise from the beds after treatment to exit the apparatus, as is the case for example when perlite is expanded as aforementioned. It will be appreciated that in such an embodiment the utilisation of concentric treating regions rather than just one annular treating region as disclosed in EP-B-68853 increases the capacity of the apparatus for a given diameter.

Claims

1. Apparatus for treating matter, comprising at least two treating regions, each region being defined by a structure including a base provided with an annular fluid inlet means, the annular inlet means of the regions being disposed concentrically about an upwardly directed axis of the apparatus, means for supplying fluid to each annular fluid inlet means and means for imparting vertical and circumferential components to the flow of fluid through each inlet means for moving respective beds of said matter in said regions in respective bands along respective concentric annular paths in said regions as said fluid passes through said beds.

2. Apparatus as claimed in claim 1, wherein said annular inlet means of said regions are spaced axially.

3. Apparatus as claimed in claim 1 or 2, wherein said annular inlet means of said regions are spaced radially.

4. Apparatus as claimed in claim 3 when appended to claim 2, wherein the axially upper of said annular inlet means is disposed radially outwardly of the other annular inlet means.

5. Apparatus as claimed in claim 4 comprising more than two said regions, wherein the or each of said other annular inlet means is disposed radially inwardly of the inlet means next above it.

6. Apparatus as claimed in any one of claims 2 to 5, comprising means for supplying matter to be treated to the region provided with the axially upper of the annular inlet means, means for enabling matter to be extracted from the region provided with the axially lower of the annular inlet means and means for transferring matter from the or each region whose annular inlet means is disposed above that of another region to said other region.

7. Apparatus as claimed in any one of claims 3 to 5, comprising means for supplying matter to be treated to the region provided with the radially outer of the annular inlet means, means for enabling matter to be extracted from the region provided with the radially inner of the annular inlet means, and means for transferring matter from the or each region whose annular inlet means is disposed radially outwardly of that of another region to said other region.

8. Apparatus as claimed in claim 3, comprising means for supplying matter to be treated to the region provided with the radially inner of the annular inlet means, means for enabling matter to be extracted from the region provided with the radially outer of the annular inlet means, and means for transferring matter from the or each region whose annular inlet means is disposed radially inwardly of that of another region to said other region.

9. A method of treating matter, in at least two treating regions, wherein in each region a bed of said matter is moved in a band continuously along an annular path by passing fluid through the bed along said path, the annular paths of the regions being concentric.

10. A method as claimed in claim 9, wherein the annular paths of the regions are spaced axially.

11. A method as claimed in claim 9 or 10, wherein the annular paths of the regions are spaced radially.

12. A method as claimed in claim 11 when appended to claim 10, wherein the axially upper of said annular paths is disposed radially outwardly of the other annular path or paths.

13. A method as claimed in claim 12, wherein the matter is passed through more than two regions and wherein the or each annular path is disposed radially inwardly of the annular path next above it.

14. A method as claimed in any of claims 10 to 13, wherein the matter to be treated is supplied to the region having the axially upper of said annular paths and extracted from the region having the axially lower of said annular paths, the matter being transferred from the or each region having an annular path disposed above that of another region to said other region.

15. A method as claimed in any one of claims 11 to 13, wherein the matter to be treated is supplied to the region having the radially outer of said paths and extracted from the region having the radially inner of said paths, the matter being transferred from the or each region whose annular path is disposed radially outwardly of that of another region to said other region.

16. A method as claimed in claim 11, wherein the matter to be treated is supplied to the region having the radially inner of said paths and extracted from the region having the radially outer of said paths, the matter being transferred from the or each region whose annular path is disposed radially inwardly of that of another region to said other region.

17. A method as claimed in any one of claims 9 to 16, wherein said fluid which is passed through said beds comprises gaseous matter which treats, or reacts with, the matter in said beds.

18. A method as claimed in claim 17, wherein the gaseous matter comprises combustion gases which heat the matter in said beds during passage through said beds.

19. A method as claimed in any one of claims 9 to 18, wherein said fluid which is passed through said beds comprises liquid matter which treats, mixes with, or reacts with the matter in said beds during passage through said beds.

20. A method as claimed in any one of claims 9 to 19, wherein said fluid which is passed through said beds comprises air.

21. A method as claimed in any one of claims 9 to 20, wherein said matter which is passed through said treating regions comprises particulate matter.

22. A method as claimed in any one of claims 9 to 21, wherein the matter which passes through said treating regions comprises liquid matter.

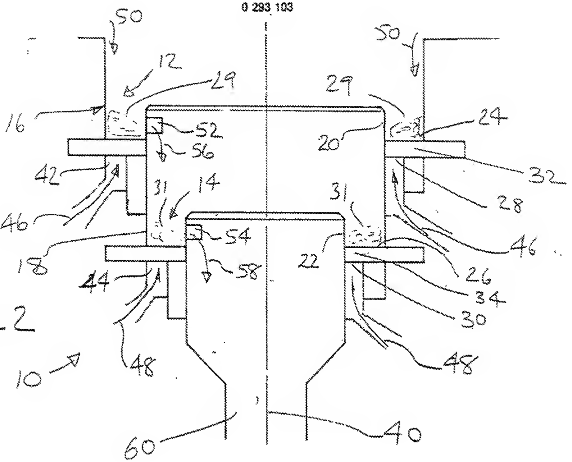
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FIG 2

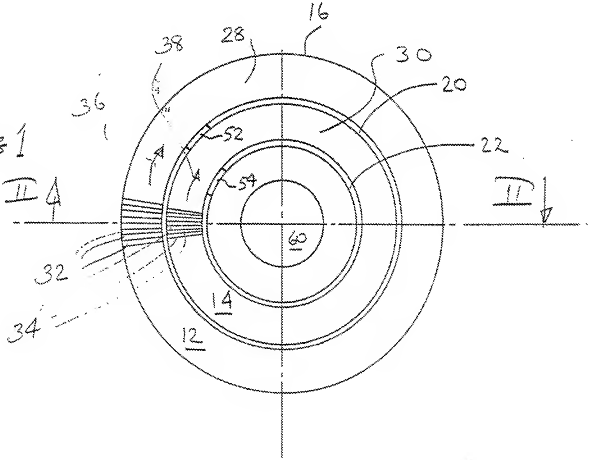
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FIG 1

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(54) **Method and apparatus for processing matter in a turbulent mass of particulate material.**

(57) For processing matter in a turbulent mass of particulate material, a substantially annular processing region (14; 104; 206) is provided and is preferably in the form of a substantially annular processing chamber having a radially inner wall which includes a waist (38; 122). A flow of fluid and matter to be processed are admitted to the processing region through one or more inlets (28, 46; 108, 124; 214, 220) with the flow of fluid being directed generally circumferentially into the processing region. In the processing region, matter to be processed is embedded in a compact turbulent band of particulate material for processing. Once processing is complete, the processed matter is withdrawn from the processing region, preferably by entrainment in an exhaust flow of the fluid.

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METHOD AND APPARATUS FOR PROCESSING MATTER IN A TURBULENT MASS OF PARTICULATE MATERIAL

This invention concerns a method and apparatus for processing matter in a turbulent mass of particulate material.

Processes in which matter to be processed is enveloped in a heated bed of particulate material for thermal treatment have been available for a number of years.

Currently, such processes are carried out in apparatus commonly known as a fluidised bed furnace. A conventional fluidised bed furnace comprises a housing providing a processing chamber which is partially filled with refractory particles. The floor of the chamber constitutes a perforate plate and, in use, a mixture of gas and combustion air is forced up through this plate. As a result, the particles in the chamber are supported and form a turbulent mass resembling a boiling liquid. This is the "fluidised bed". Heating of the bed is effected either by combustion of the gas/air mixture below the plate before it enters the chamber, or by internal combustion of this mixture within the bed.

Matter to be processed is supplied into the bed and mixes with the heated particles by virtue of the turbulence of the bed. Such matter is thus brought into intimate contact with the heated particles and, in this environment, is effectively heated and at the same time undergoes processing. After treatment, the processed matter is extracted from the bed.

In theory, the fluidised bed just described provides an effective heat transfer mechanism which offers benefits in a variety of thermal processing systems.

In practice, however, the application of fluidised bed furnaces has been limited because of difficulties over regulating the temperatures and transfer of heat inside the bed,and problems in separating the products of certain thermal processes from the bed at the appropriate moment.

Such drawbacks have various causes:

The application of heat to the bed is at least to some extent localised. And, because the bed as a whole remains static and fluidisation is achieved by a vertical flow of the gas/air mixture within the processing chamber, the lateral movement of the bed particles is random. Consequently, the transfer of heat to some regions of the bed may be limited with the result that a non-uniform heat distribution is obtained within it.

Also, the random movement of the particles tends to give rise to uneven horizontal mixing of the particles and matter to be processed which affects the exchange of heat between the two.

Further, the currents inside the bed may actively oppose or hinder the extraction of processed matter, when solids are among the products of the process. Since these currents have no fixed direction, the solids will not naturally be made to migrate to any particular area of the processing chamber for removal, nor will they have a natural tendency to separate from the particles in the bed when they are ready for extraction. Therefore, control of the withdrawal of solid products from the chamber and their retention time within the bed tends to be uncertain.

Not only do these factors make for inefficiencies in operation but also they render the furnace unsuitable for applications where the control of temperature or retention time for solids is critical.

The present invention relates to a process in which matter to be processed is made to circulate, preferably with and within a turbulent mass of particulate material, about an axis of a processing chamber during treatment. A centrifugal effect is thus created which may be combined with the effects of gravity and a flow of fluid through the processing chamber to generate an environment where the treatment of matter and its extraction from the chamber after processing can be readily controlled.

More especially, by means of the invention, matter to be treated is embedded and centrifugally retained within a compact but turbulent toroidal band of particles which are circulating about the axis of the processing chamber. There, the matter is processed and when processing is complete the products are automatically separated from the particulate mass by entrainment in a flow of fluid leaving the mass.

In other words, the present invention is particularly applicable to the treatment of matter whose reponse to forces such as gravity and centrifugal action varies on processing.

Accordingly, one aspect of the invention features a method for processing matter in a turbulent mass of particulate material, comprising:

generating a swirling flow of fluid within a processing region;

providing particulate material within said processing region;

employing said swirling flow of fluid to cause said particulate material to assume a compact band and circulate about an axis of said processing region in a turbulent manner;

supplying matter to be processed into said

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compact band of particulate material;

processing said matter within said compact band of particulate material; and

withdrawing processed matter from said compact band of particulate material.

By virtue of the invention, each particle travels to and fro inside the processing region along the full length of the compact band and uniform processing conditions may be obtained. The motions of the particles within the particulate mass are determined by the combined effects of the fluid flow, gravity, and the centrifugal forces created by the swirling of the fluid, and the result is a thorough and continuous mixing of these particles and matter to be processed, on the supply of such matter into the band of particles. Consequently, a very efficient processing operation may be achieved using only a shallow band of particles.

An important aspect of the invention is the construction of the apparatus in which the method may be performed. This construction is designed to promote the formation of a turbulent circulating mass of particles in operation and to encourage natural separation from the mass of matter when processed.

In general terms, the apparatus comprises:

means defining a substantially annular processing region for receiving a mass of particulate material;

an inlet or inlets for admitting a flow of fluid and matter to be processed to said processing region;

means for directing said flow of fluid generally circumferentially of said processing region;

an outlet or outlets for said flow of fluid and for processed matter; and

said means defining said processing region being profiled so as to maintain said mass of particulate material substantially in a compact turbulent band within said processing region in response to said flow of fluid in use.

The preferred embodiment has a flow regulating structure which is shaped to cause a variation in fluid velocity within the substantially annular processing region. By appropriate configuration of the flow regulating structure, such variation may be arranged to enhance mixing of the particles internally of the particulate mass, thereby enhancing the efficiency of processing. Advantageously, the flow regulating structure provides an area of reduced velocity in the processing region.

In accordance with this embodiment of the invention, processing apparatus comprises:

means defining a substantially annular processing chamber which is radially inwardly enlarged in a region between its axial limits;

an inlet or inlets for admitting a flow of fluid and matter to be processed to said processing chamber;

means for directing said flow of fluid generally circumferentially of said processing chamber to cause matter to be processed to circulate around said processing chamber for processing; and

an outlet or outlets for said flow of fluid and for processed matter.

More especially, the means defining the substantially annular processing chamber may include a central, flow-regulating, structure which defines a radially inner wall of the chamber and which is formed with a waist providing the radially inwardly enlarged region.

There are numerous applications for the present invention, both in thermal processing and in chemical processing, and also in other fields such as grinding. For example, it may be employed in thermal processes including the gasification of solid fossil fuels and the expansion of e.g. leca, perlite, sand and vermiculite. It also has application in the drying of matter by heat, in the grinding of matter, and in the mixing of matter.

The invention is described further, by way of example, with reference to the accompanying drawings, in which :

Figure 1 is an elevation, partly in section, of a first embodiment of apparatus according to the invention;

Figure 2 is a fragmentary view of the same apparatus, again partly in section, showing in greater detail a processing chamber illustrated in Figure 1;

Figure 3 is an elevation, partly in section, of a further emobodiment of apparatus according to the invention;

Figure 4 is a fragmentary perspective view showing a detail of the apparatus of figure 3;

Figure 5 is a plan section through a further embodiment of apparatus according to the invention;

Figure 6 is a vertical section through the apparatus

of figure 5; and

Figure 7 is a flow diagram of a process for expanding perlite employing the present invention.

Referring initially to figures 1 and 2, these show apparatus according to the present invention which, in this instance, is employed as an expansion furnace in the expansion of perlite.

The furnace comprises a generally tubular housing 10 arranged with its axis vertical. A central structure 12 within the housing co-operates with it to define an annular processing chamber 14 and a fluid flow path 16 passing through the chamber 14. The flow path 16 has a lower section 18 for supplying a mixture of gas and combustion air generally upwardly into the annular chamber 14, and an upper section 20 for carrying exhaust fluid away from an upper region of the chamber 14.

As shown in figures 1 and 2, the lower section 18 of the flow path 16 is defined by a funnel-shaped portion 22 of the housing 10 and a conical portion 24 of the central structure 12, both of which widen towards the annular chamber 14. Consequently, the flow cross-section, which is circular at the narrower end of the housing portion 22, is annular in the vicinity of the annular processing chamber 14. This annular flow cross-section is arranged to decrease in area towards the chamber 14.

Within the narrower end of the housing portion 22, there is a burner 26. Combustion air is supplied through the narrower end of the housing portion 22 in use and, mingling with gas from the burner 26, flows upwardly to the annular processing chamber 14. As a result of the decreasing section of the flow path, the velocity of the fluid speeds up as it approaches this chamber.

Entry of the fluid into the chamber 14 is effected through an annular inlet opening 28 which is co-extensive with the region of the flow path 16 at the upper end of its lower section 18.

A plurality of vanes 30 are disposed in the inlet opening to impart rotational motion to the fluid flow entering the chamber 14 so that the fluid circulates about the axis of the chamber as it rises. These vanes form part of a circular disc 32 which rests in the upper end of the housing portion 22 and supports the central structure 12 inside the housing 10, being mounted between the conical portion 24 and the remainder of the central structure 12. The vanes lie around the periphery of the disc 32 and are simply angled away from the remainder of the disc about generally radially extending lines in the plane of the disc (see figure 2). As illustrated, each vane 30 spans the inlet opening 28 in the radial direction, and the vanes are equispaced

about the opening 28 so that the supply of fluid to the chamber 14 is substantially evenly distributed around it.

This is an important feature of the apparatus.

The chamber 14 itself is defined between a cylindrical portion 34 of the housing 10 and a waisted portion 36 of the central structure 12. By virtue of the waist 38 in the portion 36 of the structure 12, the chamber 14 is radially inwardly enlarged in a region between its axial ends. Accordingly, the vertical component of the fluid flow passing through the chamber 14 is subject first to a decrease and then to an increase in velocity during the passage of the fluid.

The combined effects of the inclined vanes in the inlet opening 28 and the waist 38 in the central structure 12 on the fluid travelling along the path 16 result in a highly turbulent swirling flow in the chamber 14.

At the upper end of this chamber, there is an annular outlet opening 40 which is co-extensive with the region of the flow path 16 at the lower end of its upper section 20. This upper section 20 of the flow path 16 is provided by an inverted funnel shaped portion 42 of the housing 10 and a further conical portion 44 of

of the central structure 12. The facing surfaces of the housing portion 42 and the conical portion 44 of the central structure are substantially parallel and converge away from the chamber 14. Thus, these members define an annular region in the flow path of decreasing cross sectional area in which the velocity of the fluid increases as the flow departs from the chamber 14.

One or more inlet openings to the chamber 14 are also provided in the wall of the cylindrical housing portion 34. A chute 48, from for example a hopper (not shown), leads to the or each inlet to supply firstly refractory particles and subsequently perlite to the chamber 14.

Operation of the apparatus is as follows:

A rising flow of heated fluid is generated within the lower section of the flow path 16 by supplying combustion air through the narrower end of the housing portion 22, supplying gas to the burner 26, and initiating combustion in the vicinity of the burner 26. The velocity of the fluid increases as it approaches the chamber 14.

On encountering the vanes 30, the heated fluid is deflected into the chamber 14 and caused to rotate about the chamber's axis whilst still rising. The fluid swirls around the chamber 14 in a turbulent fashion and then exhausts from the chamber through the annular outlet

opening 40.

Particulate material is injected into the chamber 14 by way of the chute or chutes 48 and, under the influence of fluid in the chamber 14, becomes a turbulent mass heated by the fluid. The turbulent mass assumes the form of a compact toroidal band 50 within which the particles circulate.

Complex flows occur within this band under the combined effects of gravity, centrifugal action and gaseous flow, and the particles circulate both around the axis of the chamber 14 and to and fro within the band 50.

Although the theory behind the motion of the turbulent mass 50 has not yet been fully developed, it is believed that the circulation occurring within the turbulent mass has a first component flow and in some instances, but not all, also a second component flow.

These two component flows are illustrated in figures 1 and 2 by arrows.

The first component flow is in the close vicinity of the wall of the cylindrical housing portion 34. Particles are lifted up against this wall by the rising flow of gas, and in the upper regions of the turbulent mass, tumble inwardly remaining close to the wall. At the same time, the particles are displaced circumferentially by the rotational movement of the fluid in the chamber.

The particles which circulate according to the second component flow follow a path which is directed inwardly and upwardly from the inlet opening with the entering fluid. As they reach the innermost edge of the turbulent mass 50, centrifugal forces take over and urge them generally outwardly again. The particles move outwardly, and also circumferentially, until they meet and merge with the particles in the first component flow. At this point, gravity dominates and the particles drop to the bottom of the bed for recirculation.

Observation of the mass 50 during testing suggests that this is what occurs within it, although the precise paths of the particles have not been determined.

It is thought that by appropriate adjustment of the velocity of the fluid flowing into the chamber 14 and the positioning of the vanes 30, the circulation of particles within the chamber 14 can be modified so that the first component flow predominates and the second disappears almost altogether. Then, the particles would flow up the outside of the mass 50, circumferentially and downwardly in the upper region of the mass to its inner area, and finally outwardly and circumferentially to repeat the cycle.

In any event, the motion of the particles in the toroidal band 50 causes very thorough mixing and

a uniform distribution of heat throughout the band.

Once the circulating mass 50 has acquired a sufficiently high temperature, perlite is supplied to the chamber 14 by way of the chute or chutes 48. The perlite drops into the turbulent band and is held embedded there by gravity acting on it, whilst it mixes with the particles and is heated.

On heating, the perlite expands and becomes increasingly influenced by the rising flow of fluid passing through the chamber 14 due to change in density. As a result, the perlite has a tendency to migrate generally upwardly to the top of the turbulent mass with the fluid flow. Here, it is located towards the axial centre of the chamber 14 where the vertical velocity of the fluid is starting to increase. The perlite becomes entrained in the fluid and is lifted towards the annular outlet 40 at an increasing rate, being expelled from the chamber 14 with the exhaust fumes.

The apparatus has two significant advantages. Firstly, the high degree of turbulence within the particulate mass 50 and the circulation of the particles throughout the chamber 14 in the circumferential direction gives rise to a uniform temperature distribution within the mass and a very efficient transfer of heat between the

particles, fluid and the perlite. Secondly, the fully expanded perlite separates naturally and automatically both from the circulating mass and from matter yet to be fully processed.

A further and preferred embodiment of the invention is illustrated in figures 3 and 4. Although the construction of the apparatus shown in these figures differs from that already discussed, the principle of operation is the same.

This embodiment features a housing 100 containing a central structure 102, and defining with this structure an annular processing chamber 104 through which a fluid flow path 106 extends vertically.

As before, the central structure 102 is waisted, providing a radially inwardly enlarged region in the chamber 104 between its axial limits. An annular inlet opening 108 for fluid is situated at the base of the chamber 104 and contains a plurality of overlapping vanes 110. Also, the chamber constricts upwardly towards an annular outlet opening 112 for exhaust fluid and expanded perlite.

Lower portions 114, 116 of the housing 100 and central structure 102 respectively, together define a lower section 118 of the flow path 106. This lower section 118 of the flow path 106 is generally annular

and decreases in cross-section as it approaches the chamber 104. Combustion air is supplied into the lower region of this flow path section 118 where a burner 120 burns the air with the gas to generate a heated flow of fluid rising into the chamber 104.

On entering the chamber, the heated fluid is deflected circumferentially by the vanes 110, and within the chamber it swirls and becomes turbulent by virtue of the waist 122 in the central structure 102.

In these respects, the apparatus illustrated in figures 3 and 4 is substantially the same as that of figures 1 and 2.

The present embodiment differs from the preceding one chiefly in the arrangement by which particulate material and perlite are supplied to the processing chamber, and additionally in the design of the support structure for the vanes and the exhaust section of the flow path 106.

In this case, the furnace features a continuous annular inlet opening 124 for the particulate material and, later, the perlite, which is situated in the central structure 102 at its waist 122. Particulate material and perlite are supplied to this opening 124 by way of a chute 126, and a distribution arrangement 128 located internally of the central structure 102.

More especially, the central structure 102 is divided into two separate parts in the present instance.

These comprise a lower part 130 which includes the lower portion 116 of the structure 102, and an upper part 132. Both parts are supported by and fixed relative to the housing.

The lower part 130 includes a support 134 for a rotatable disc 136 and a motor 138, the motor being operable to rotate the disc. The disc 136 has a central bump 140 as shown in figure 3, and its periphery co-incides with the upper edge of a substantially frustoconical outer wall 142 of the lower part 130. A portion of the wall 142 serves as the lower portion of the radially inner wall of the chamber 104 below the waist 122.

The upper part 132 of the central structure 102 serves to support the chute 126 above the bump 140 in the disc 136, and has a frustoconical wall 143 providing the upper portion of the radially inner wall of the chamber 104 above the waist 122.

In use, the disc 136 is set into motion by the motor 138, and particulate material is supplied into the chute 126. The particles drop onto the bump 140 and are flung outwardly towards the periphery of the disc 136.

From the disc periphery, the particles fall downwardly over the wall 142 in a thin curtain into the chamber 104. Thus,the particles are uniformly distributed around the chamber 104.

Heated fluid is driven upwardly into the chamber 104, and the particles form a heated turbulent toroidal mass behaving in the manner described in relation to figures 1 and 2.

Then, the perlite is injected into the chamber 104 by way

of the chute 126 and rotating disc 136. Like the particulate material, the perlite falls as a thin curtain into the chamber 104 and is evenly distributed around the chamber. This promotes particularly efficient mixing of the perlite with the turbulent mass.

Turning to figure 4, this shows the vane structure of the present embodiment which serves to deflect fluid entering the chamber 104 in a circumferential direction. The vane structure comprises an inner ring 144 forming part of the lower part 130 of the central structure 102, and an outer ring 146 forming part of the housing 100. The two rings 144, 146 face one another and have regularly spaced slots 148 in their opposed faces. The slots 148 are arranged in corresponding pairs, one in each ring 144, 146 and are inclined in relation to the plane surfaces of these rings. A respective vane 150 is fitted into each corresponding pair of slots.

As illustrated, the vanes thus overlap to a significant extent and define narrow flow passages 152 between one side of the vane structure and the other.

This promotes a clean flow in the fluid entering the chamber 104. Such controlled flow assists in supporting the turbulent toroidal mass above the vanes 110 and in inhibiting particles from falling through the vanes into the lower section 118 of the flow path 106.

The exhaust section of the flow path 106 is arranged as follows:

At the upper end of the chamber 104, the flow path 106 is directed radially into a scroll shaped upper portion 152 of the

housing 100, which is hollow. The expanded perlite leaving the chamber 104 is flung outwardly into this housing portion 152 and flows round it to an outlet (not shown) at its outer-most end. The swirling motion of the fluid and expanded perlite leaving the chamber 104 assists in carrying the particles to the outlet.

This embodiment of the invention is particularly advantageous for a number of reasons. Each opening into and out of the chamber 104 embraces its full circumference so that the supply of fluid and other matter into the chamber and the exhaust of products from the chamber occurs uniformally over its entire operational extent. Efficient processing is a natural consequence of this. Another advantage lies in the construction and arrangement of the vanes 110 as mentioned above.

Figures 5 and 6 show an alternative form of apparatus according to the invention.

This comprises an outer housing 200. The housing 200 defines a combustion chamber 202 and a heating chamber 204. Within the chamber 204, there is a processing chamber 206 formed by a shallow, roughly cylindrical, hollow body 208.

The housing 200 is arranged to contact the body 208

at top and bottom, but so that a helical flow path 210, leading from the combustion chamber 202, is provided between the housing 200 and the circumferential wall 212 of the body 208. The path 210 leads to an inlet opening 214 in the wall 212 as shown.

Gas and combustion air are supplied in use to the chamber 42 where combustion takes place, and the fluid then circulates around the circumference of the body 208 before entering the processing chamber 206. The exterior of the body 208 is thus heated and, to promote an even temperature along the wall 212, a plurality of annular ribs 216 are provided. The body 208 and ribs 216 are formed mainly from a material such as cast iron or ceramic.

The hot gas enters the processing chamber 214 in a generally tangential manner through the inlet 204 and, thereafter, initially tends to follow the interior of the wall 212 round the chamber. The fluid is then exhausted from the chamber 206 through an outlet 218 formed in the top of the body 208 in its axial direction.

An additional inlet 220 extends into the chamber 202 through the top of the body 208 and the adjacent wall of the housing 200. This inlet 220 serves initially for supplying particulate material and subsequently for injecting perlite into the chamber 206. The inlet

220 is arranged radially inwardly of the wall 212 so as to direct the particulate material and the perlite tangentially of the chamber.

In operation, heated fluid is caused to flow round the exterior and then the interior of the wall 212 before being exhausted through the outlet 218. Particulate material is supplied into the chamber 206 and, under the influence of the fluid flow, hugs the inside of the wall 212 and is caused to flow in a turbulent manner about the annular exterior region of the processing chamber 206. The fluid rotating about the axis of the chamber 206 causes this turbulent mass to rotate and to be urged continually outwards against the wall 212 and the mass, therefore, forms a compact toroidal band 222.

This band 222 is heated both by the transfer of heat through the wall 212 and by the heat of the fluid circulating within the chamber 206.

When perlite is added to the chamber 206, it is flung forcefully outwards against and into the turbulent band 222 and is heated therein. As the perlite expands, it tends to work its way towards the inner edge of the band 222 and it becomes entrained in the flow of fluid passing to the outlet 218.

The fluid and expanded perlite are exhausted

from the chamber together.

A process for expanding perlite employing the present invention is shown diagrammatically in figure 7.

A supply of perlite in its natural condition is fed to a drier and a pre-treatment chamber in a conventional manner. In the pre-treatment chamber, the perlite is heated to a temperature of 250 degrees to 300 degrees centigrade, in preparation for insertion into the expansion furnace according to the invention.

Gas and combustion air are provided from supplies of the same and are impelled into the expansion unit where they are combusted to achieve an internal temperature in the range of 900 degrees to 1100 degrees centigrade. The perlite added into the expansion furnace is thus heated and expanded to form insulating material.

A stream of hot exhaust fluid carrying the expanded perlite and products of combustion is expelled from the expansion furnace into a heat recovery unit where heat is withdrawn and redirected to the pre-treatment chamber for initial heating of the perlite and to the combustion air supply for pre-heating this air.

The cooled exhausts from the expansion furnace then pass to a cyclone for separating the expanded perlite from the fluid and any small contaminent particles.

The fluid is expelled into the atmosphere by way of a filter for collecting such particles, and the expanded perlite is conveyed, by way of an additional cooler, to packaging apparatus.

Vermiculite can also be expanded in any of the furnaces illustrated in figures 1 to 6 and by the system shown in figure 7.

Other applications for the invention include the gasification of solid fossil fuels.. In this instance, one of the two furnaces described with reference to figures 1 to 4 is preferably used and instead of arranging for combustion of the gas/air mixture to take place in the lower section of the flow path and below the vanes in the inlet to the processing chamber, the mixture is ignited within the turbulent mass in the chamber.

The apparatus described may also be employed for grinding purposes. The fluid supplied to the processing chamber may or may not then be heated but the rate of flow must be controlled to ensure very rapid circulation of the particulate material in the turbulent mass. Then, when matter to be processed is supplied to the chamber and becomes embedded in the particulate mass, the frictional forces generated by the rapid turbulent motion of the particles abrades

the matter to be processed and can reduce it to a fine powder.

In experimental testing of the apparatus shown in figures 1 to 4, it has been found that, in fact, processing of certain matter, for example perlite and vermiculite, will occur in the absence of the toroidal band of particulate material. Then, on insertion into the processing chamber, the matter to be processed itself forms a turbulent toroidal band which is processed, as by heating, simply by the swirling flow of fluid. The overall operation is not so efficient but nevertheless processing can be achieved.

As has been mentioned previously, although in the described embodiments combustion of the gas and air is effected outside the processing chamber, this is not essential. Combustion can be made to take place within the chamber if desired.

Various modifications can also be made in the construction of the apparatus.

For example, instead of forming the waist in the central structure in the manner illustrated in figures 1, 2 and 3 by arranging two frustoconical wall portions of this structure in inverted relation and thereby defining a precisely angled corner in the processing chamber, the waist may be defined by a radially inwardly curved wall

portion of the central structure. Also, it should be noted that where the waist is defined by frusto-conical wall portions of the central structure, the cone angles of each may be either the same or different.

Alternative arrangements for the vanes of the two furnaces shown in figures 1 to 4 are also possible. In these two embodiments, each vane is inclined only about a radially extending line. However, each vane may be lifted at its outer edge as well so that it is inclined both in the generally circumferential direction of the annular inlet opening for fluid and in the generally radial direction. This would result in a change in the particle flows within the turbulent toroidal mass but would still generate a high degree of mixing of the particles.

A further modification resides in the provision of an additional outlet at or adjacent the lower end of the annular processing chamber in the furnaces of figures 1 to 4. For example, referring to figure 1, the cylindrical portion 34 of the housing 10 may be somewhat enlarged relative to the wider end of the housing portion 22 and a substantially annular opening may be created at the lower outer edge of the processing chamber 14. Any relatively heavy matter or particles in the circulating band of particulate material

will have a tendency to gravitate to this region and will consequently drop from the chamber 14. The construction of the furnace shown in figure 3 may be altered in a similar manner. Such arrangements are advantageous for separating relatively heavy particles of processed or waste matter from the toroidal band in a manner which does not block the annular inlet opening to the processing chamber. Consequently, these arrangements may be useful, for example, in instances where the or some of the processed matter is too heavy to be easily extracted from the processing chamber by entrainment in the exhaust flow of gas or where the supply of matter to be processed is contaminated.

The described constructions make for compact, and therefore easily insulated, apparatus. A stable temperature may be obtained within the processing chamber and thorough mixing of matter to be processed and particles in the turbulent mass occurs. The retention time of matter being processed in the turbulent mass can also be accurately determined to obtain the optimum results. Consequently, efficient processing can be realised in a practical manner.

CLAIMS

1. Apparatus for processing matter in a turbulent mass of particulate material, said apparatus comprising:

means (10,12; 100,102; 208) defining a substantially annular processing region (14;104;206) for receiving a mass of particulate material;

an inlet or inlets (28,46; 108,124; 214, 220) for admitting a flow of fluid and matter to be processed to said processing region;

means (30; 110; 210) for directing said flow of fluid generally circumferentially of said processing region;

an outlet or outlets (40; 112; 218) for said flow of fluid and for processed matter; and

characterised in that said defining means (10,12; 110,102; 208) has a profile shaped to maintain said mass of particulate material substantially in a compact turbulent band within said processing region (14; 104; 206) in response to said flow of fluid in use.

2. Apparatus for processing matter in a turbulent mass of particulate material, said apparatus comprising:

means (10,12; 100,102) defining a substantially annular processing chamber (14; 104);

an inlet or inlets (28,46; 108,124) for admitting

a flow of fluid and matter to be processed to said processing chamber;

means (30; 110) for directing said flow of fluid generally circumferentially of said processing chamber to cause said matter to be processed to circulate around said processing chamber for processing;

an outlet or outlets (40; 112) for said flow of fluid and for processing matter; and

characterised in that said defining means (10,12; 100,102) is radially inwardly enlarged in a region between its axial limits.

3. Apparatus according to claim 2, characterised in that said defining means include a structure (12;102) defining a radially inner wall of said processing chamber (14;104) and defining a waist (28; 122) in said radially inner wall.

4. Apparatus according to claim 3, characterised in that said structure (12; 102) has two frusto-conical sections which are inverted relative to one another to define said waist (38;1..).

5. Apparatus according to any of claims 2 to 4, characterised in that said inlet or inlets comprise an annular inlet opening (28; 108) to said processing chamber (14; 104) for said flow of fluid, said inlet opening being disposed at a base of said processing chamber, and in that said directing means comprise a plurality of overlapping vanes (30; 110) arranged in said inlet opening.

6. Apparatus according to any of claims 2 to 5, characterised in that said inlet or inlets comprise an annular inlet opening (124) to said processing chamber (108) for said matter to be processed.

7. Apparatus according to claim 6 when dependent from claim 3 or 4, characterised in that said inlet opening (108) for said matter to be processed is provided in said structure (102) at said waist (122).

8. Apparatus according to any of claims 2 to 7, characterised in that said outlet or outlets comprise an annular outlet opening (40; 112) at an upper axial end of said processing chamber (14; 104).

9. A method for processing matter in a turbulent mass of particulate material, comprising:

generating a flow of fluid within a processing region (14; 104; 206);

providing particulate material within said processing region;

employing said flow of fluid to cause said particulate material to circulate about an axis of said processing region;

supplying matter to be processed into said particulate material;

processing said matter within said particulate material;

withdrawing processed matter from said particulate material; and

characterised by causing said flow of fluid to swirl within said processing region and employing said swirling flow of fluid to cause said particulate material to assume a compact turbulent band.

10. A method according to claim 9, characterised by defining said processing region within an annular processing chamber (14; 104) and directing a supply of fluid generally circumferentially into said processing chamber and varying the velocity of said fluid in the axial direction of said processing chamber to generate

said swirling flow of fluid and to cause said particulate material to assume said compact turbulent band and circulate about said axis.

11. A method according to claim 10, characterised by defining a waist (38; 122) in a radially inner wall of said processing chamber (14; 104) for varying said velocity.

12. A method according to any of claims 9 to 11, characterised by generating an exhaust flow of said fluid and entraining said processed matter in said exhaust flow of said fluid for withdrawing said processed matter from said compact band.

13. A method according to any of claims 9 to 12, characterised by arranging said processing region (14; 104) with its axis generally vertical, and causing said swirling flow of fluid to pass generally vertically through said processing region.

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FIG. 1

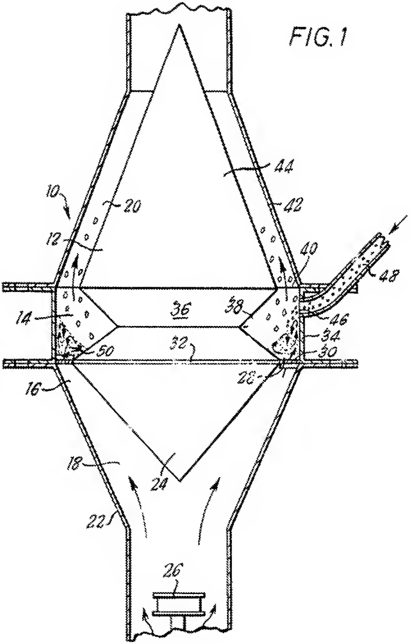

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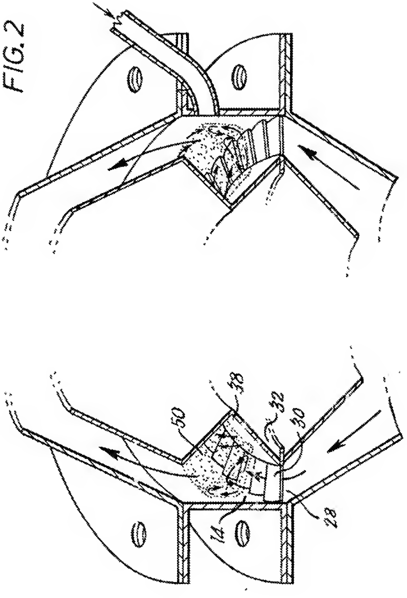
FIG. 2



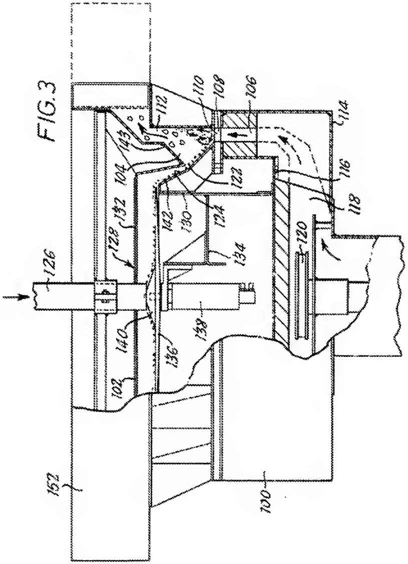


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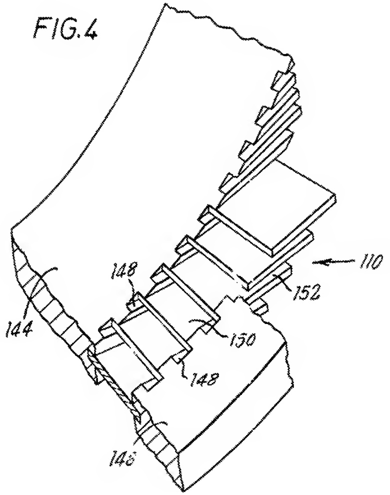
FIG.3

FIG.4



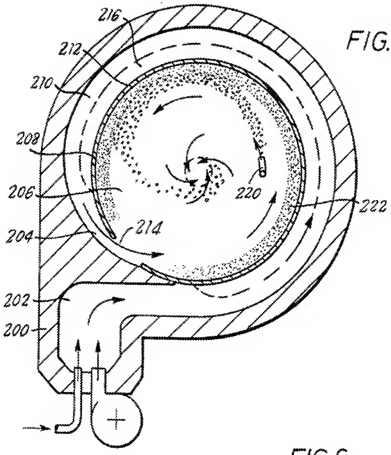


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FIG.5

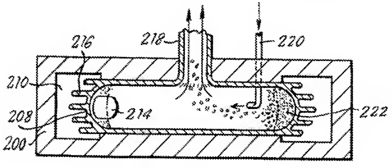

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FIG.6

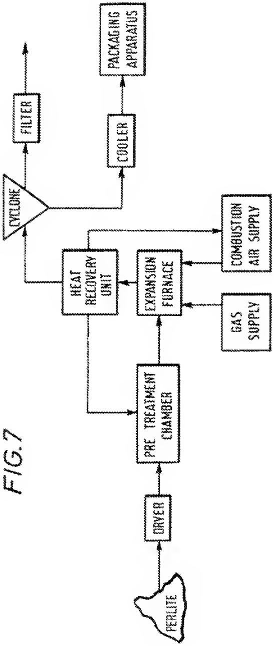
PERLITE
DRYER
PRE TREATMENT CHAMBER
EXPANSION FURNACE
GAS SUPPLY
COMBUSTION AIR SUPPLY
HEAT RECOVERY UNIT
CYCLONE
FILTER
COOLER
PACKAGING APPARATUS

FIG.7

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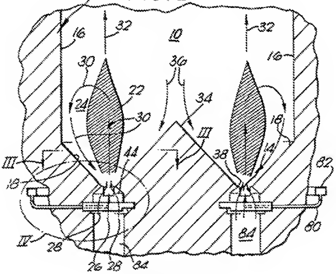
(54) Heating matter.

(57) A method of heating matter comprises supplying a gaseous mixture, which is reactable to produce heat, at a temperature above that at which spontaneous ignition occurs to a heating zone such that the gaseous mixture reacts to provide a heated fluid flow in said heating zone, and supplying matter to be heated to said heating zone.

FIG. 2



EP 0 346 004 A1

HEATING MATTER

This invention relates to heating matter and is particularly, but not exclusively, applicable to methods of heating matter using apparatus as disclosed in Specification EP-B-68853 and copending British Specifications Nos. 2202618A, 2203670A, 2205049A and 2211597A, and in which matter is moved in a band continuously along an annular path in an annular zone by directing fluid flow into the zone over the annular extent thereof with both circumferential and vertical flow components. It will be understood that by utilising heated fluid for the fluid flow over at least a portion of the annular extent of the zone, there will be a heat transfer between the heated fluid and matter as the heated fluid passes through the band thereby heating the matter.

A gaseous mixture which is reactable to produce heat may be used to provide a heated fluid flow, for example the gaseous mixture may be a combustible gaseous mixture, typically comprising an air-gaseous fuel mixture.

However it will be understood that, for the above process of producing a heated fluid flow to be efficient in a method of heating matter as described above wherein the heated fluid flow passes through a band of the matter which is moving continuously along an annular path in an annular zone, the reaction which produces the heated fluid flow should occur in the zone and must be rapid to ensure that the reaction is substantially completed within the extent of the band, which for example is typically 50mm deep.

We have found that the required rapid reaction can be achieved by supplying the gaseous mixture at a temperature above that at which fuel dissociation occurs such that spontaneous ignition occurs and no flame front exists.

The invention in its broadest aspect includes a method of heating matter comprising supplying a gaseous mixture, which is reactable to produce heat, at a temperature above that at which spontaneous ignition occurs, to a heating zone such that the gaseous mixture reacts in said heating zone to provide a heated fluid flow therein, and supplying matter to be heated to said heating zone.

Advantageously the reaction utilised is a combustion reaction and the invention also includes a method of heating matter comprising supplying a combustible gaseous mixture at a temperature above that at which spontaneous ignition occurs to a heating zone such that a combustion reaction occurs in said heating zone to provide a heated fluid flow therein and supplying matter to be heated to said heating zone.

Furthermore, in presently preferred embodiments a combustible air-gaseous fuel mixture is utilised and the invention further includes a method of heating matter comprising supplying a combustible air-gaseous fuel mixture at a temperature above that at which spontaneous ignition of the gaseous fuel occurs to a heating zone such that a combustion reaction occurs in said heating zone to provide a heated fluid flow therein, and supplying said matter to said heating zone.

Although the invention is applicable to other methods of heating matter, it is especially applicable to the above-described method, in which case the matter to be heated is moved in a band continuously along an annular path in an annular zone by directing fluid flow into said zone over the annular extent thereof with both circumferential and vertical flow components, said fluid flow comprising said gaseous mixture over at least a portion of the annular extent of said zone, and the reaction thereof being substantially completed within the extent of said band.

The fluid flow may comprise said gaseous mixture over the annular extent of said zone.

The matter may comprise particulate material which forms a resident bed moving in said band along said annular path.

The gaseous mixture may be directed into a first annular region of said annular zone, which region is contiguous with and disposed inwardly of a second annular region of said annular zone such that said reaction occurs substantially in said first annular region, and said matter is circulated between said regions whilst moving in said band.

In embodiments of the invention described hereinafter the gaseous mixture comprises an air-gaseous fuel mixture and the fluid flow is directed into said annular zone through an annular inlet comprising an annular array of fixed inclined vanes arranged in overlapping relationship, said gaseous fuel being mixed with heated air immediately upstream of respective passages defined between said vanes and combustion occurring downstream of said vanes.

Preferably the air-gaseous fuel mixture is confined substantially to the region above the vanes by directing respective flows through said annular inlet at the radially inner and outer edges thereof with radially outwardly and radially inwardly flow components respectively.

The gaseous fuel may comprise natural gas, and in an embodiment of the invention an air-natural gas mixture is supplied at a temperature greater than 700°C. The temperature of this mixture is obtained by mixing the natural gas with heated air at a temperature of less than about

1000°C, for example between 850 and 900°C.

In order that the invention may be better understood, some embodiments thereof will now be described, reference being had to the accompanying drawings, in which:

Figure 1 is a graph showing the effect of the temperature of an air-gaseous fuel mixture on combustion rate;

Figure 2 is a schematic axial cross-section of an apparatus for heating matter;

Figure 3 is a cross-section along the line III-III of Figure 2;

Figure 4 shows the portion indicated by IV in Figure 2 to a larger scale and in more detail than in Figure 2;

Figure 5 is a section taken along the line V-V in Figure 4 showing four blades of the apparatus;

Figure 6 is a top, part section view of three blades of the apparatus;

Figure 7 is a perspective view of a single blade of the apparatus;

Figure 8 is a schematic top plan view of another apparatus for heating matter; and

Figure 9 is an axial cross-section of the same apparatus taken along the line VIII-VIII of Figure 8.

Referring first to Figure 1, the effect of the temperature of a combustible air-gaseous fuel mixture prior to combustion on the rate of combustion is indicated. It will be noted that combustion of the mixture at the lowest temperature A is comparatively slower than combustion of the mixture at higher temperatures B and C, the temperature/time curves in the latter cases being substantially J-shaped, the temperature generated by the combustion rising rapidly soon after combustion commences. In the embodiments of the present invention described hereinafter an air gaseous fuel mixture is provided for combustion at a temperature above that at which dissociation of the fuel occurs so that rapid combustion is achieved.

Referring now to Figures 2 and 3, the illustrated apparatus comprises a chamber 10 having a circumferential wall 12 which is disposed radially outwardly of an annular inlet 14. The wall 12 slopes towards the annular inlet, and as shown comprises a cylindrical portion 16 extending upwardly from a sloping portion 18. In the illustrated apparatus, the sloping portion 18 extends downwardly to the outer edge of the annular fluid inlet.

Within the chamber 10 there is a first annular region disposed above the annular inlet and designated 22 in Figure 2 and a second annular region contiguous with the first annular region and disposed between that region and the circumferential wall 12. The second region is disposed above the sloping portion 18 of the wall in the embodiment.

The apparatus also includes means for directing fluid through the annular inlet 14 with vertical and circumferential flow components. The direction of the fluid flow through the inlet is indicated in Figure 2 by arrows 26 and 28. The flow of fluid through the inlet is such that it will move matter in the chamber 10 in a band continuously along an annular path in the regions 22, 24. This matter is moved vertically and circumferentially whilst in the first region 22 by the flow of fluid therein, is moved out of this flow of fluid in the first region into the second region by circumferential force and is directed back into the first region by the slope 18. The movement of the matter into and out of the flow of fluid is indicated by arrows 30 in Figure 2. It will be understood that whilst the matter is being circulated as indicated by arrows 30 it is also moving in the circumferential direction. Furthermore, it will be understood that when the matter moves into the outer annular region 24 it is not subjected therein to the flow of fluid and falls under gravity towards the annular inlet 14 whereupon it re-enters the fluid flow and is moved circumferentially and vertically by the fluid flow therein.

The fluid exits the chamber 10 upwardly as indicated by arrows 32 after it has passed through the annular region 22.

In the illustrated apparatus the chamber 10 includes a second circumferential wall 34 extending upwardly and disposed radially inwardly of the annular fluid inlet 14. This circumferential wall 34 has a slope towards the annular fluid inlet such that matter introduced centrally into the chamber as indicated by arrows 36 will be directed into the first annular region 22 above the annular fluid inlet 14. Whilst the whole of the second circumferential wall is provided with such a slope in the embodiment and this slope extends to the radially inner edge 38 of the annular fluid inlet 14, it is to be understood that only a portion of the circumferential wall 34 need be provided with such a slope and that slope need not extend to the edge 38.

Referring now particularly to Figures 4 to 7, the means for directing fluid through the annular inlet 14 with vertical and circumferential flow components in the illustrated apparatus comprises an annular array of fixed inclined vanes 40 arranged in overlapping relationship, and defining therebetween respective flow passages 42 which extend vertically and circumferentially. A portion of the annular array of vanes is schematically illustrated in Figure 3, however it is to be understood that the array extends completely around the annular inlet 14.

Each vane 40 is part of a respective blade 44 which is best shown in Figure 7. Adjacent blades 44 nest together as illustrated in Figures 5 and 6 so as to dispose the vanes in overlapping relationship with the passages therebetween. Each blade

44 is also provided with respective side vanes 46 and 48 extending upwardly from radially outer and radially inner sides of its vane 40. The side vanes 46 and 48 of the blades overlap to define therebetween respective flow passages 50 and 52. The vanes 46 and 48 are inclined towards each other and the flows through the passages 50 and 52 at the radially outer and inner edges of the inlet 14, indicated by arrows 28 in Figure 2, have radially inwardly and radially outwardly flow components respectively causing the flow through the passages 42, indicated by arrow 26 in Figure 2, to be confined substantially to the annular region 22 above the vanes 40.

The blades are provided with radially outer and radially inner mounting portions 54 and 56, by which they are mounted on annular ledges 58 and 60 respectively radially outwardly and radially inwardly of the annular inlet 14. Intermediate the mounting portions the blades are provided with a ribbed portion 62 which extends vertically to the upstream ends of the vanes 40, 46 and 48. The ribs 64 of the portion 62, extend vertically and are provided on only one side of the portion 62 in the illustrated blade and define with the plain opposite side 66 of the portion 62 of an adjacent blade vertically extending flow passage means 68 communicating with the flow passages 42, 50 and 52 defined between that blade and the adjacent blade. Each blade is provided with a passage for receiving a gaseous fuel distributor, or so-called 'sparge' pipe 70. This passage comprises a bore 72 in an enlarged free end portion 74 of the mounting portion 54 and a slot 76 aligned with the bore 72 and extending therefrom through the remaining portion 78 of the mounting portion 54 into the ribbed portion 62 and terminating short of the mounting portion 56. In the ribbed portion 62 the slot is completely open at the plain side 66 thereof but bridged at spaced apart locations by the ribs 64 at the other side.

As shown in Figures 5 and 6 a pipe 70 is received in the passage therefor in alternate blades 44, each pipe being provided with radial openings arranged to supply gaseous fluid to the flow passages defined by the blade in which the pipe is fitted and the blades on each side of that blade. The pipes 70 are all connected via conduit means 80 to an annular gas header tube, or manifold, 82 disposed externally of the circumferential wall 12 of the chamber.

In use heated air is caused to swirl about an annular chamber 84 beneath the annular inlet 14 and to flow through the passage means 68 defined between adjacent blades in the passages 42, 50 and 52 defined between the vanes of those blades. This air mixes with gaseous fuel from the pipes 70 to form a heated air-gaseous fuel mixture in the passage means 68 and this mixture is combusted in the annular region of 22 of the chamber 10 above the inlet 14. The air-gaseous fuel mixture is heated prior to combustion by the mixing of the gaseous fuel with the heated air to a temperature above that at which spontaneous ignition of the gaseous fuel occurs such that a rapid combustion reaction occurs as explained hereinbefore in connection with Figure 1. The rate of combustion is such that although the velocity of the air mixing with the fuel is greater than the flame propagation velocity thereof so that the resulting flow is able to move matter in a band along an annular path in the chamber 10, combustion occurs, and is substantially completed, within the extent of the band, that is before the mixture passes through the matter in the band. Additionally because the gaseous fuel is mixed with the air immediately upstream of the passages 42, most of the combustion occurs downstream of the blades 44 and accordingly they are not subjected to the full heat of the combustion reaction.

The above-described embodiment is particularly applicable for use in heating matter comprising a particulate material which has to be heated to a predetermined temperature which is at or below the temperature at which fast combustion reactions occur, or which is adversely affected by being continuously subjected to temperatures above that predetermined temperature during treatment.

In such an application the combustion reaction occurs substantially in the first annular region 22 in the chamber 10. The particulate matter to be heated is supplied to the chamber centrally thereof and is fed to the region 22 by the slope of the inner circumferential wall 34. This particulate material is then moved in a band continuously along an annular path in the regions 22 and 24. The particulate material is moved vertically and circumferentially by the fluid flow whilst in the first region, is moved out of the flow in the first region into the second region by circumferential force and is thereafter directed back into the first region by the slope 16 of the outer circumferential wall 12. Thus, the particulate material is moved in a band continuously around the regions 22, 24 whilst being circulated in this band between the regions such that the material moves into and out of the heated flow during movement around the regions.

It will be appreciated that as the combustion reaction is maintained spaced from the walls 18 and 34 these are not raised to the temperature of the region 22 and therefore contact by the particulate matter of these walls does not adversely affect the matter.

Although the above-described embodiment is applicable to heating many types of particulate matter, particular examples of its application are

the heating of perlite, slate and clay to expand the same.

Referring now to Figures 8 and 9, there is illustrated an apparatus for heating matter which is similar to the apparatus illustrated in Figures 2 and 3. Accordingly like reference numerals in these figures designate like or similar parts. The annular inlet 14 is spanned by an annular array of inclined vanes 86 (only a portion of the array being shown in Figure 8) which are preferably arranged in overlapping relationship for directing fluid flow into the annular zone 88 above the inlet 14 with both circumferential and vertical flow components for moving a resident bed of particulate matter in the zone 88 continuously along an annular path in a compact band 90.

Heated air is caused to swirl about annular chamber 84 beneath the inlet 14 and to flow between the vanes 86 into the zone 88. This air mixes with gaseous fuel from fuel pipes 70 immediately upstream of the vanes to form a heated air-gaseous fuel mixture which is combined in zone 88. As in the previous embodiment, the heated mixture prior to combustion is at a temperature above that at which spontaneous ignition of the gaseous fuel occurs such that a rapid combustion occurs. The rate of combustion is such that combustion is substantially completed within the extent of the band of particulate matter forming the resident bed, thus efficiently heating that matter. Further matter to be heated is either added to the resident bed or passed therethrough such that heat is transferred to the further matter from the heated particulate matter of the bed. This further matter may comprise gases, liquids or solids.

In the case where the further matter to be heated is a gas, the heated air-gaseous fuel mixture is passed through the bed along a portion of the annular extent of the zone 88 to heat the bed and the gas is passed through the bed along another portion of the annular extent of the zone 88 to be heated by the matter in the bed.

One example of solid matter which may be heated by being added to the resident bed is fine powder.

The apparatus and method described above in connection with Figures 8 and 9 may be used to heat matter, especially particulate matter directly without the use of a resident bed. In this case it will be appreciated that the matter to be heated is introduced into the zone 88 and is moved continuously along an annular path in a compact band by the passage of the heated fluid flow provided by the combustion of the heated air-gaseous fuel mixture through the matter whilst heating it.

It is to be understood that an arrangement of nested blades with fuel sparge pipes fitted to alternate blades substantially as described in connection with Figures 4 to 7 may be used in the apparatus shown in Figures 8 and 9 instead of the more simple overlapping vane arrangement schematically illustrated.

Although other gaseous fuels, such as propane, methane and vapourised oil, may be used, in the embodiments described above the gaseous fuel is natural gas and the air-natural gas mixture prior to combustion is at a temperature above 700°C. To obtain such a mixture temperature the air is preferably at a temperature of between 850 and 900°C. Other air temperatures may be used, but it has been found that at air temperatures above about 1000°C carbon deposits are likely to form in the fuel pipes 70. Thus it is advantageous to use an air temperature of less than about 1000°C.

Although the embodiments have been described utilising a heated air-gaseous fuel mixture to provide a heated flow, other combustible gaseous mixtures or gaseous mixtures which react to produce heated flow and whose reaction rate is typified by a substantially J-shaped temperature/time curve which the mixture prior to commencement of the reaction is at a temperature above that at which spontaneous ignition occurs may be used.

Claims

1. A method of heating matter comprising supplying a gaseous mixture, which is reactable to produce heat, at a temperature above that at which spontaneous ignition occurs to a heating zone such that the gaseous mixture reacts to provide a heated fluid flow in said heating zone, and supplying matter to be heated to said heating zone.

2. A method of heating matter comprising supplying a combustible gaseous mixture at a temperature above that at which spontaneous ignition occurs to a heating zone such that a combustion reaction occurs in said heating zone to provide a heated fluid flow therein and supplying matter to be heated to said heating zone.

3. A method of heating matter comprising supplying a combustible air-gaseous fuel mixture at a temperature above that at which spontaneous ignition of the gaseous fuel occurs to a heating zone such that a combustion reaction occurs in said heating zone to provide a heated fluid flow therein, and supplying said matter to said heating zone.

4. A method as claimed in claim 3, wherein the air- gaseous fuel mixture is provided at said temperature by mixing gaseous fuel with heated air.

5. A method as claimed in any one of the preceding claims, wherein the matter to be heated is moved in a band continuously along an annular path in an annular zone by directing fluid flow into

said zone over the annular extent thereof with both circumferential and vertical flow components, said fluid flow comprising said gaseous mixture over at least a portion of the annular extent of said zone, and the reaction thereof being substantially completed within the extent of said band.

6. A method as claimed in claim 5, wherein said fluid flow comprises said gaseous mixture over the annular extent of said zone.

7. A method as claimed in claim 5 or 6, wherein said matter comprises particulate material which forms a resident bed moving in said band along said annular path.

8. A method as claimed in claim 6, wherein said gaseous mixture is directed into a first annular region of said annular zone, which region is contiguous with and disposed inwardly of a second annular region of said annular zone such that said reaction occurs substantially in said first annular region, and said matter is circulated between said regions whilst moving in said band.

9. A method as claimed in any one of claims 5 to 8 when appended to claim 3, wherein said fluid flow is directed into said annular zone through an annular inlet comprising an annular array of fixed inclined vanes, said gaseous fuel being mixed with heated air immediately upstream of respective passages defined between said vanes and wherein combustion occurs downstream of said vanes.

10. A method as claimed in claim 9, including confining said air-gaseous fuel mixture substantially to the region above the vanes by directing respective flows through said annular inlet at the radially inner and outer edges thereof with radially outwardly and radially inwardly flow components respectively.

11. A method as claimed in any one of claims 9 or 10, wherein said gaseous fuel comprises natural gas and said mixture is supplied at a temperature greater than 700°C.

12. A method as claimed in claim 11, wherein said temperature of said mixture is obtained by mixing said natural gas with heated air at a temperature of less than about 1000°C.

13. A method as claimed in claim 12, wherein said air is at a temperature of between 850 and 900°C.

FIG. 1

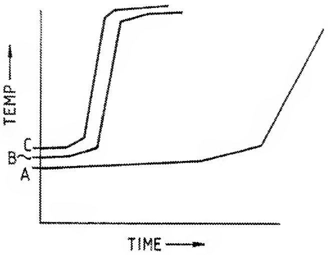


FIG. 7

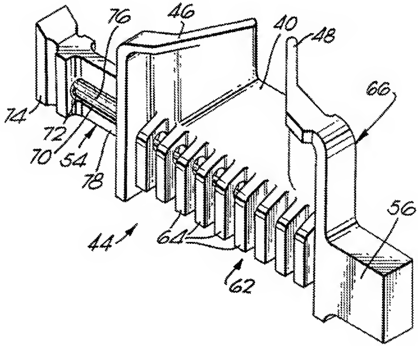
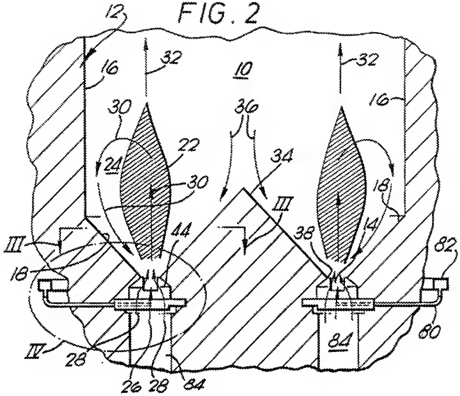


FIG. 2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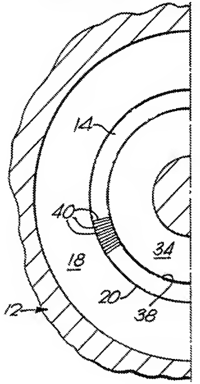
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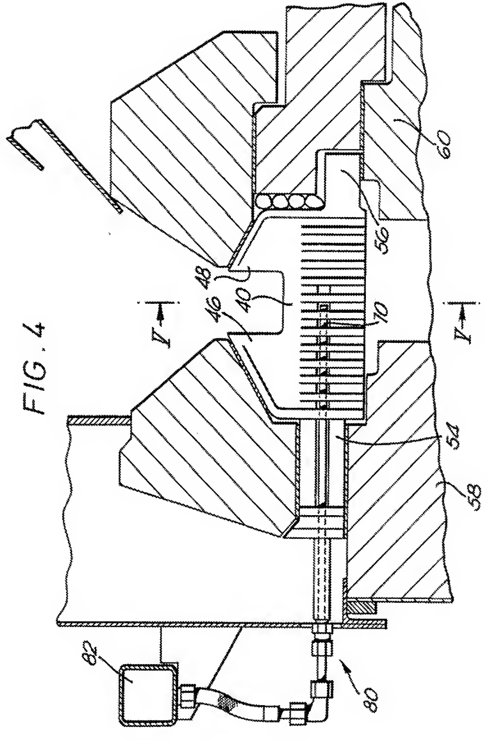
FIG. 3

FIG. 4



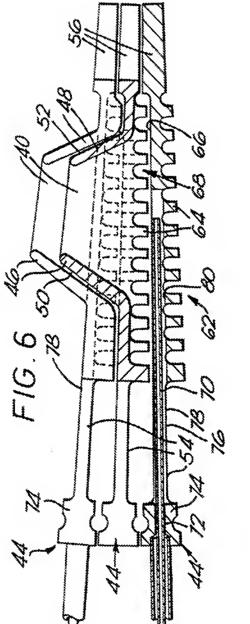

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FIG. 6

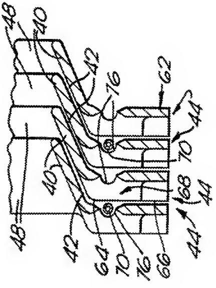
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FIG. 5

FIG. 9

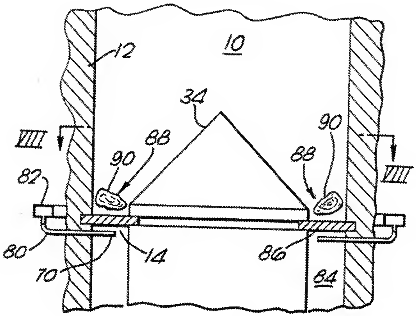
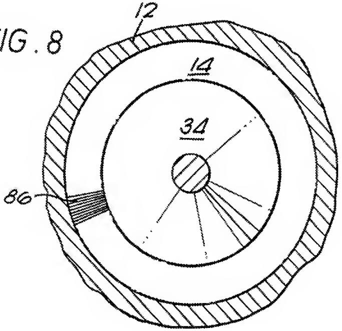


FIG. 8



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 5528

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A,D	EP-A-0 068 853 (JEZWORTH LTD) * Claims; figures *		F 23 C 11/02 F 27 B 15/14
A	GB-A-2 044 905 (BRITISH PETROLEUM) * Claims; figures *		
A	EP-A-0 261 303 (DEUTSCHE BABCOCK) * Claims; figures *		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)
F 23 C F 27 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21-09-1989	COULOMB J.C.

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